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BLAST CASTING AT MINTO COAL MINE, NEW BRUNSWICK

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BLAST CASTING AT MINTO COAL MINE, NEW BRUNSWICK

by

H.G. Naidu*

ABSTRACT

Over 17 million cubic metres of overburden need to be removed to produce 0.5 million tonne of coal. While that is an extremely high stripping ratio by Canadian standards, it is cheaper to produce coal than to import oil for power generation. However, it is extremely important for the mine to operate at high efficiency to compete with oil and gas as the prices of these have dropped considerably. Blast Casting has a great potential in enhancing the mine performance. It was tried in the past on a limited scale. Based on these results, management considers blast casting a viable technique and recently commissioned a field trial on a larger scale. The mine was visited to study and evaluate the results of that trial.

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EMPLOI DE L'ABATTAGE À L'EXPLOSIF À LA HOUILLÈRE MINTO, AU NOUVEAU-BRUNSWICK

par

H.G. Naidu*

RÉSUMÉ

Il sera nécessaire d'enlever plus de 17 millions de mètres cubes de terrains de couverture, afin de produire 0,5 million de tonne de charbon. Bien que la quantité de terrain à enlever soit élevée par rapport à la norme canadienne, il est plus rentable d'extraire du charbon que d'importer du pétrole pour produire de l'énergie. Par conséquent, il est important que le rendement d'exploitation de la mine soit élevé afin de faire concurrence aux prix du pétrole et du gaz malgré la baisse considérable qu'ils ont connu sur le marché. La méthode de l'abattage à l'explosif a beaucoup de potentiel pour accroître le rendement d'une mine. Dans le passé, les essais réalisés à l'aide de cette méthode ont été effectués sur une petite échelle. Les résultats obtenus lors de ces essais ont permis à la Direction de la mine de considérer l'abattage à l'explosif comme une technique viable et, dernièrement, des essais à grandeur réelle sur le terrain ont été réalisés à la mine. La visite de la mine avait pour but d'étudier et d'évaluer les résultats de ces essais.

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INTRODUCTION

Minto is the only coal mine in the province of New Brunswick. Originally, owned and operated by N.B. Coal Ltd. ownership was transferred to New Brunswick Power in 1986. The cost of coal production is relatively high mainly due to a high stripping ratio (S.R). Even then this mine was opened in the 70's, because it was cheaper to produce coal than to import oil. When this mine was first opened in 1970's the thermal power generation by coal was estimated to be more economical than one generated by imported oil. The situation is different now due to a drop in oil prices. This is putting an additional pressure on management to reduce production costs. In an effort to lower production costs several technological developments have been undertaken at the mine site. One of these is the application of blast casting. Recently, with the help of Canadian Industries Limited (CIL) utilizing their new 'SABREX' blasting module, a field trial was commenced in the Marion 8200 dragline pit.

MINTO COAL MINE

GENERAL

The Minto coal mine is owned by New Brunswick Power (90%) and the Bank of Nova Scotia (10%). It is located approximately 50 km from Fredricton. The total mine reserves (proved, explored and assumed) are estimated to be 27 million tonnes of which 13 million tonnes is mineable. The only one mined coal seam is generally flat with a thickness ranging from 0.4 to 0.67 metres. The overburden thickness is over 29 metres which gives a strip ratio of 70:1. The mine produced 0.55 million tonne of coal in 1986. Coal is supplied to N.B Power and Dalhousee Power stations. It is high volatile bituminous in rank with 11000 to 12000 Btu/lb heat content. The total manpower at the mine is 250 including 25 salaried staff.

GEOLOGY

The Minto coalfield is located in central New Brunswick, and covers an area of approximately 32 km by 13 km along the northern end of Grand Lake (1). Production comes from a single seam, classed as high volatile 'A' bituminous coal, Pennsylvanian in age. The seam is essentially flat-lying

with minor undulations. Large sections of it follow the surface contours. The thicker part of the coal is found in the Minto area. A typical stratigrafic section is shown in Fig.1.

MINING METHOD

Minto is a surface mine using draglines. In all there are four pits producing 430,000 tonnes of coal annually. Approximately another 120,000 tonnes of coal per year is produced by contractors from three other pits. Draglines are used both for removing the top soil as well as the blasted overburden. The mining equipment used at the mine consists of:

- 1 Marion 8200 with a 65 cyd bucket, 3 small draglines two with 12 cyd buckets and one with a 6 cyd bucket
- 1 Caterpillar D9 L dozer
- 1 Sweeper (Caterpillar 950 loader)
- 2 966 Caterpillar front-end loaders
- 1 Marion-5 drill (electric) for 310 mm holes
- 3 Mobile drills (diesel) for 250 mm holes
- 26 Trucks (15 tonne capacity)

The normal cycle of operation in the pit is:

-1.8 to 2.4 m of top soil is removed by dragline and dumped over levelled waste dumps

-Overburden is drilled and blasted

-The blasted rock is levelled and a pad for dragline is made by a dozer

-Broken rock is removed and dumped in the mined out pit by dragline

-Sweeper cleans the top of the seam

-Dozers rip the coal up

-Coal is loaded by front-end loaders into trucks and transported to either N.B power station or to a rail loadout (for Dalhousee power station, Manitoba)

CONVENTIONAL BLASTING

Blast holes are drilled on a 9m x 9m pattern. In hard material the pattern is reduced to 7.2m x 7.2m whereas in soft rock it is increased to 13.5 m x 9m. Normally, three rows are blasted at any one time. Fig.2 shows a typical blast design. The collar in the front row is 12 m, middle row is 10.5 m and the back row is only 7.5 m. The delay between adjacent holes is

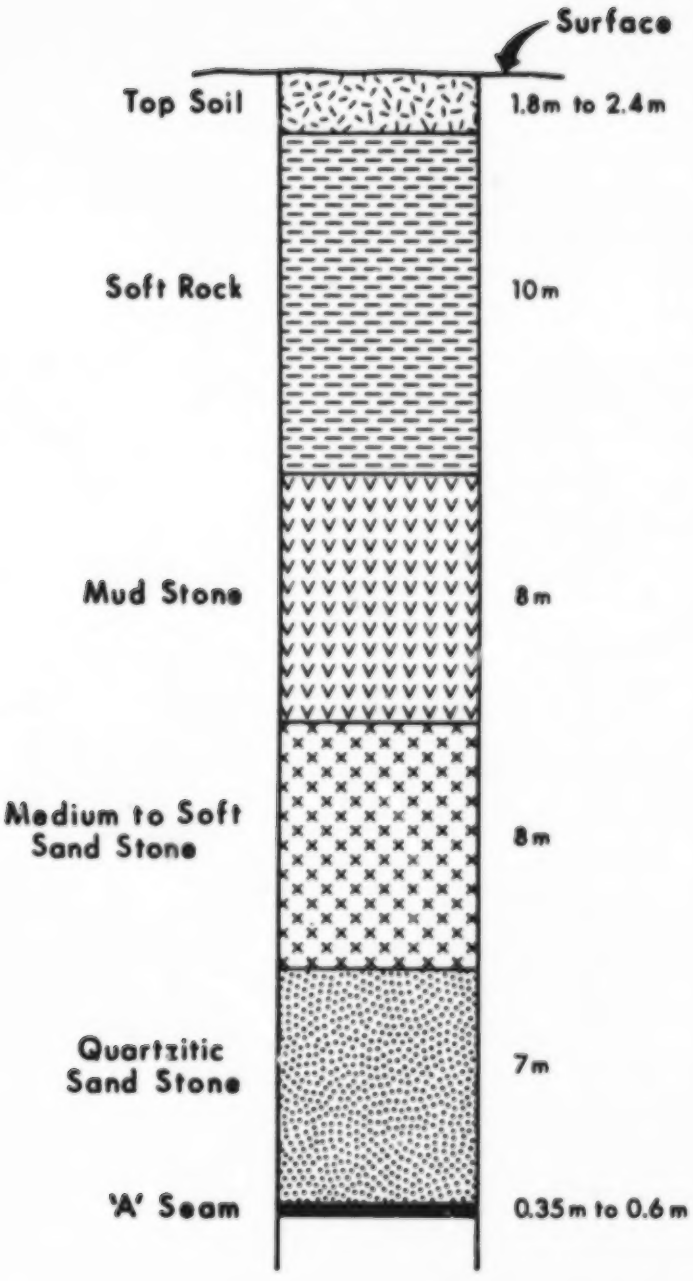
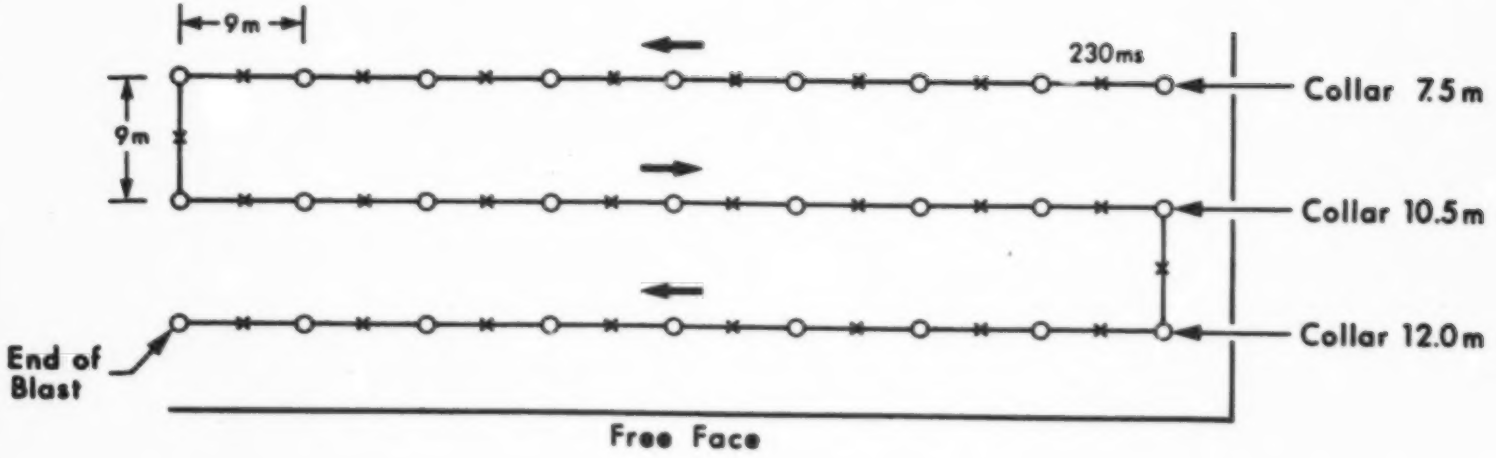


Fig. 1 Stratigraphic Section



Depth of Holes - 28m to 30m (bottom 1.2-1.5m above the seam)
Diameter of Holes - 250mm or 310mm

× - Delays
O - Holes

Fig. 2 Conventional Blast Design

230 ms which means it is virtually hole by hole blast. The explosive used is ANFO.

BLAST CASTING

GENERAL CONSIDERATIONS

The mine utilizes draglines for removing top soil as well as for handling the blasted overburden rock. The hard sand stone (quartzitic) immediately above the seam is difficult to handle with dragline. Thus the trial was aimed at meeting the following objectives:

- Limit lowering of the dragline bench to 6 to 6.6 m so that top soil could still be removed by dragline working on a lower bench
- Cast more than 40% of the blasted rock which should include mostly hard rock and leave finer material on the bench for easier digging
- Achieve competent nearly vertical highwall

PRELIMINARY INVESTIGATION THROUGH 'SABREX'

SABREX is an acronym for 'Scientific Approach to Breaking Rock with EXplosives'. It has been developed by the member companies in the ICI Explosives Group, of which C-I-L Inc., Canada is a member. It is a modular computer program which incorporates new technology with a number of tested programs that have been in use worldwide namely BOBCAT, CPEX, D CRACK, Micblast, KUZ-RAM etc. (Fig.3). It predicts the performance of blast in terms of:

- Fragment size and distribution
- Muckpile profile and face velocity
- Collar breakage
- A rupture envelope which depicts crack penetration behind and beneath blastholes
- A complete cost analysis including explosives, drilling and accessory costs

The predicted blast results are displayed as dynamic colour graphics and in tabular form (2).

In the initial phase, general information on the mine site such as; overburden depth, structure, type of rocks, results of conventional

"SABREX"

Scientific Approach to Breaking Rock with Explosives

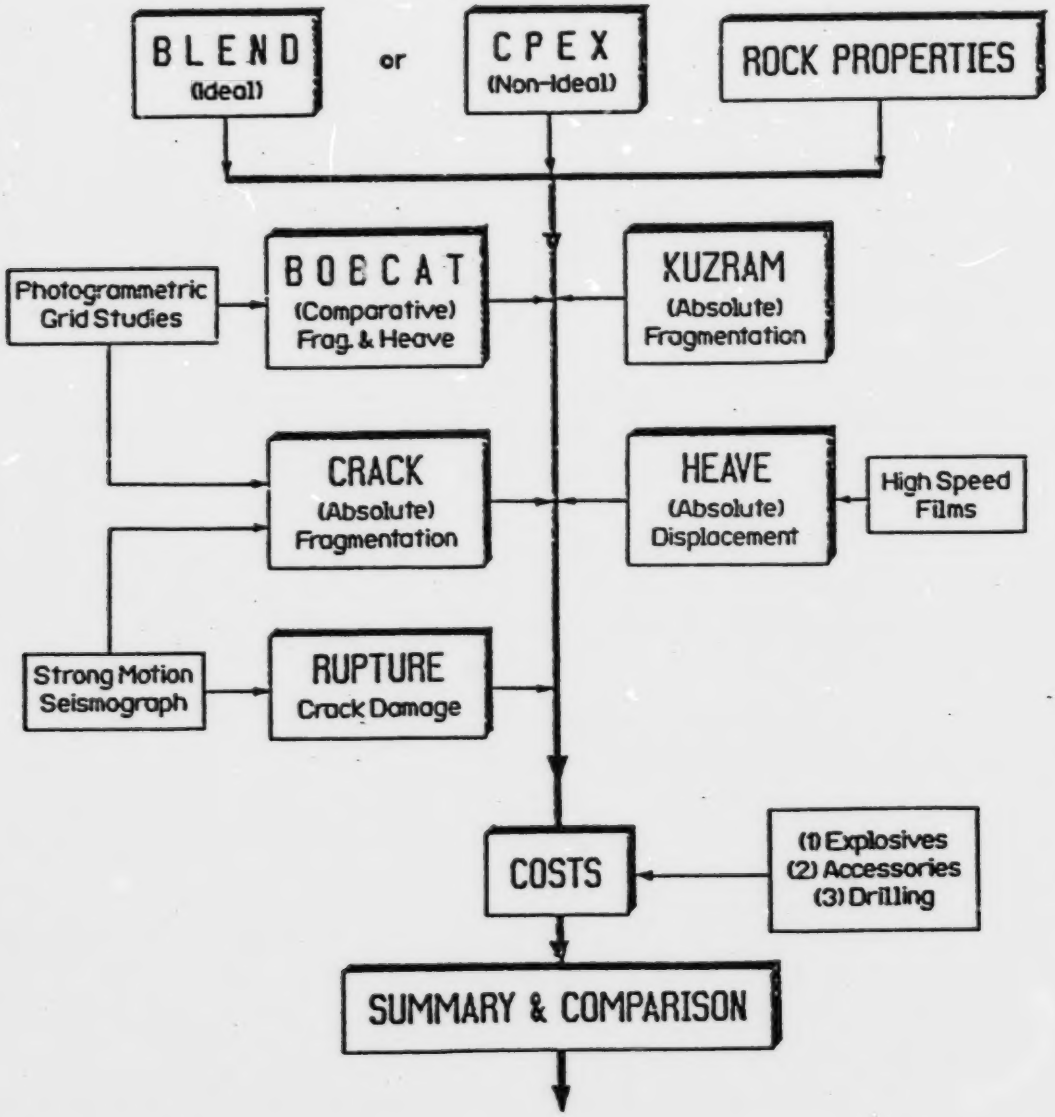


FIG. 3 The Scientific Approach to Breaking Rock with Explosives

blasting, rock fragmentation were gathered followed by collection of rock samples to determine various rock properties e.g

- Density
- Poisson ratio
- Young's modulus
- Unconfined compressive strength
- Tensile strength

These along with explosive (Heavy ANFO) properties were used as input to 'SABREX' program and then following controllable parameters were varied to achieve results meeting the objectives mentiond earlier:

- Blasthole diameter
- Pattern
- Blasthole inclination
- Collar distance
- Initiation pattern
- Delay timing
- Coal seam depth and spoil pile location

With these the following were generated to study and finalize the blast design (2):

- Crack pattern (Fig.4)
- Damage envelope (Fig.5)
- Fragmentation size
- Muck profile

The resultant blast design parameters are shown in Table-I.

DRILLING

A staggered 8.1m x 8.1m drill pattern was chosen. Accordingly, the location of holes were surveyed and pegged. A Marion 5 blast hole drill was used to drill 310 mm diameter holes. The depth of the holes varied between 28 m to 30 m with the bottoms about 1.5 m above the coal seam. There are six rows each having 11 holes.

EXPLOSIVE LOADING AND INITIATION SYSTEM

Super AN (67% ANFO and 33% Emulsion) was loaded in the holes at a density of 1.16 to 1.18. This gives a loading of 63 to 64 pounds of explosive per foot of hole. Each hole was double primed with PROCOR (1 lb

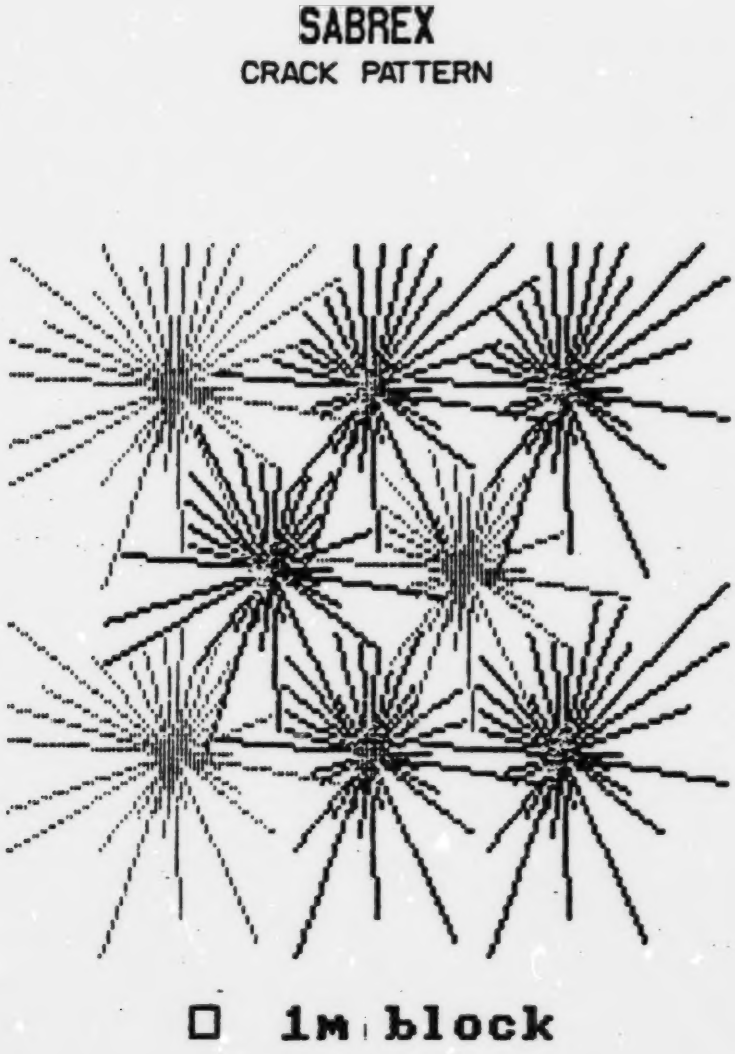


Fig. 4 The SABREX CRACK Pattern

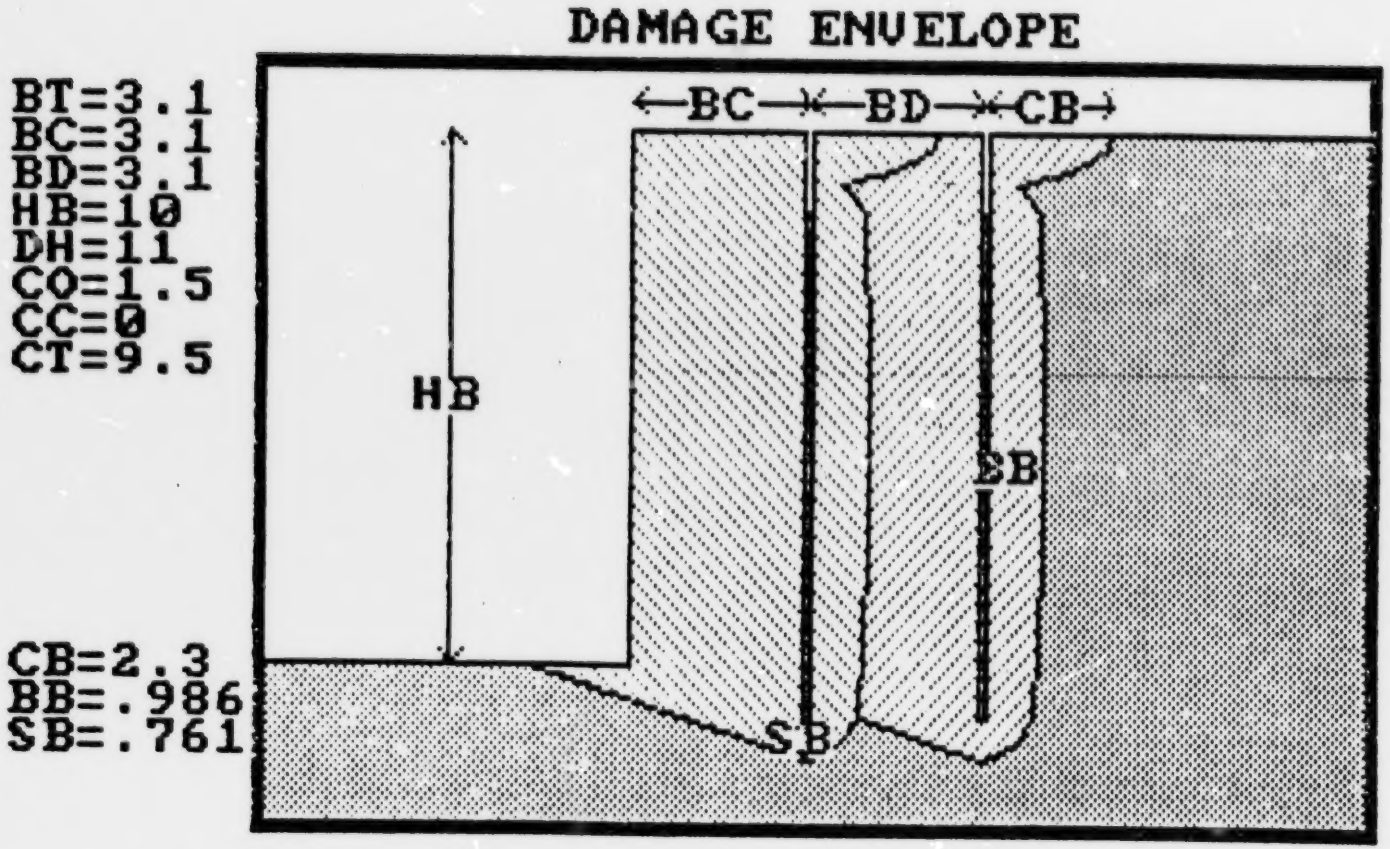


Fig. 5 Damage Envelope

cast primer). Wet holes were devatered before explosive loading. Where devatering was not possible holes were loaded with packaged slurry 'HYDROMEX' (AN,Sn and TNT). The following delays are used:

Down hole - XT NONEL No.12 with 490 ms delay

Table - I

Design factors for Blast Casting

Hole diameter		- 310 mm
Pattern size		- 8.1 m x 8.1 m
Distance from hole bottom		- 1.4 m to 1.5 m
Collar		- 9 m in front five rows
		- 12 m in back row (last)
Delays:	Downhole	- 490 ms
	Surface	- 230 m between front rows
		- 100 ms between last two rows
		- 25 ms between adjacent holes in a row
Explosive		- Super AN (67% ANFO and 33% Emulsion)
		- Hydromex (packaged slurry) in wet holes
Expl. weight/foot of hole		- 63 to 64 lbs per foot
Priming		- Double in each hole with PROCOR
Holes tie-up		- Reinforced Prima cord

Surface - 25 ms between adjacent holes

- 230 ms between rows and 100 ms in the last two rows

The collar in the front five rows is 9 m and in the last back row is 12 m. As shown in Fig.6 one primer is located at 15 m and the other at 27 m down the hole.

RESULTS

A high speed camera was used by the CIL to record the actual blast. Minto management used a video camera which fully recorded the actual events that took place in the blast cast test. The sequence of events is schematicly given in Fig.7. As planned, the dragline working bench was lowered by approximately 6.6 m and the hard quartzitic rock was propelled into the mined out pit. The resultant highwall appeared to be stable and practically vertical. The field results matched very closely with those predicted by the model. The condition of coal seam and the improvement in dragline diggability will be studied after the completion of all tne planned blasts. From visual estimates, about 40% of the material was casted. (Fig, 8).

CONCLUSION

The first large scale blast designed to cast the hard quartzitic rock directly above the seam suggests that blast casting met the design performance established for the trial. In particular, the 'SABREX' computer model has proved to be an accurate predictive tool. While a detailed cost - benefit evaluation of the blast casting trial still remains to be done, Minto's mine mangement is encouraged by the results to date.

Benefits gained from blast casting have been sufficiently encouraging to the extent that the Minto mine management feels that a 20 yd^3 bucket dragline coupled with the practice of blast casting as developed at Minto will provide digging capacity comparable to a 35 yd^3 dragline resulting in lower overall capital and operating costs. For this reason purchase of a 20 yd^3 dragline is under consideration at Minto.

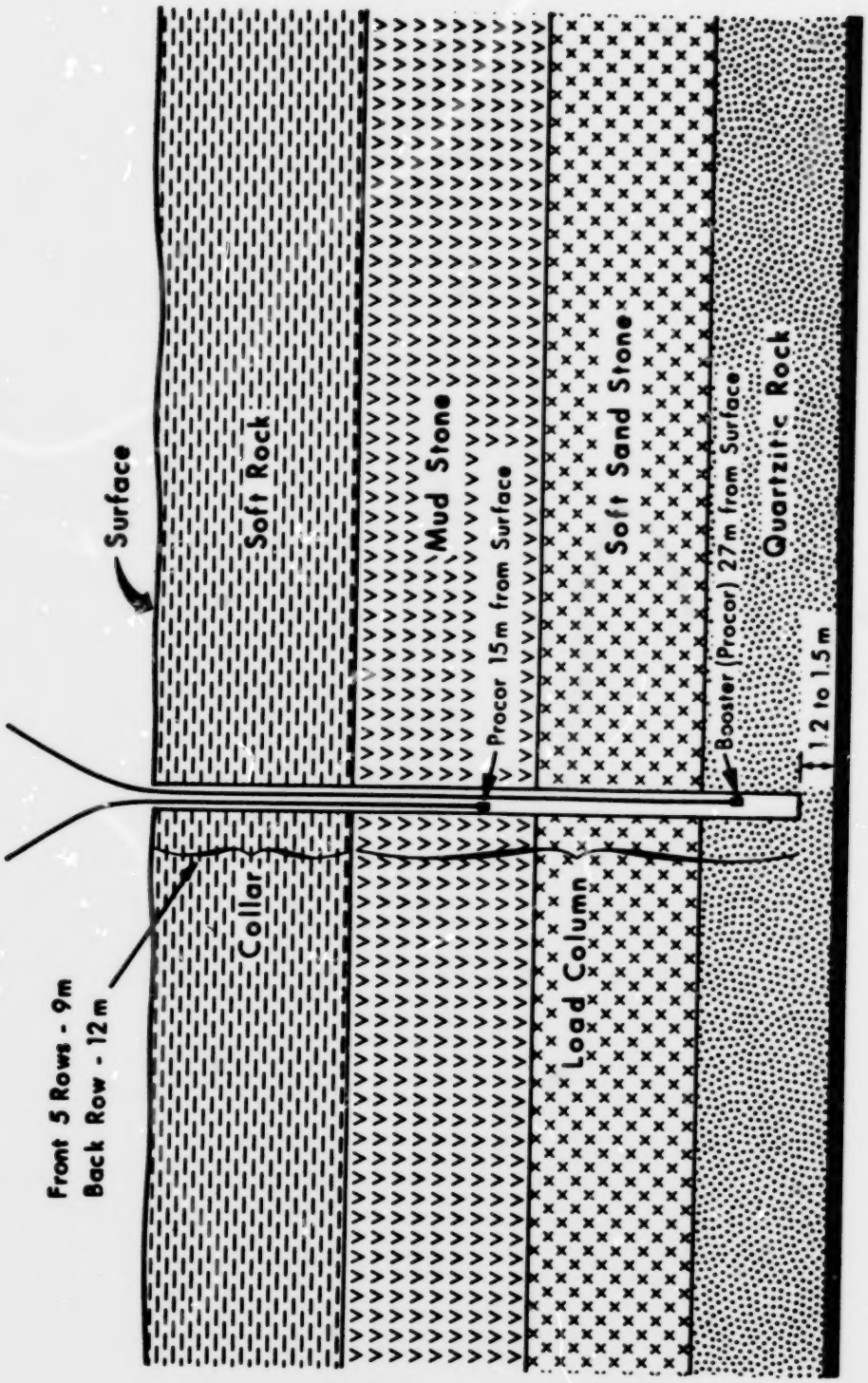


Fig. 6 Loading of a Blast Hole

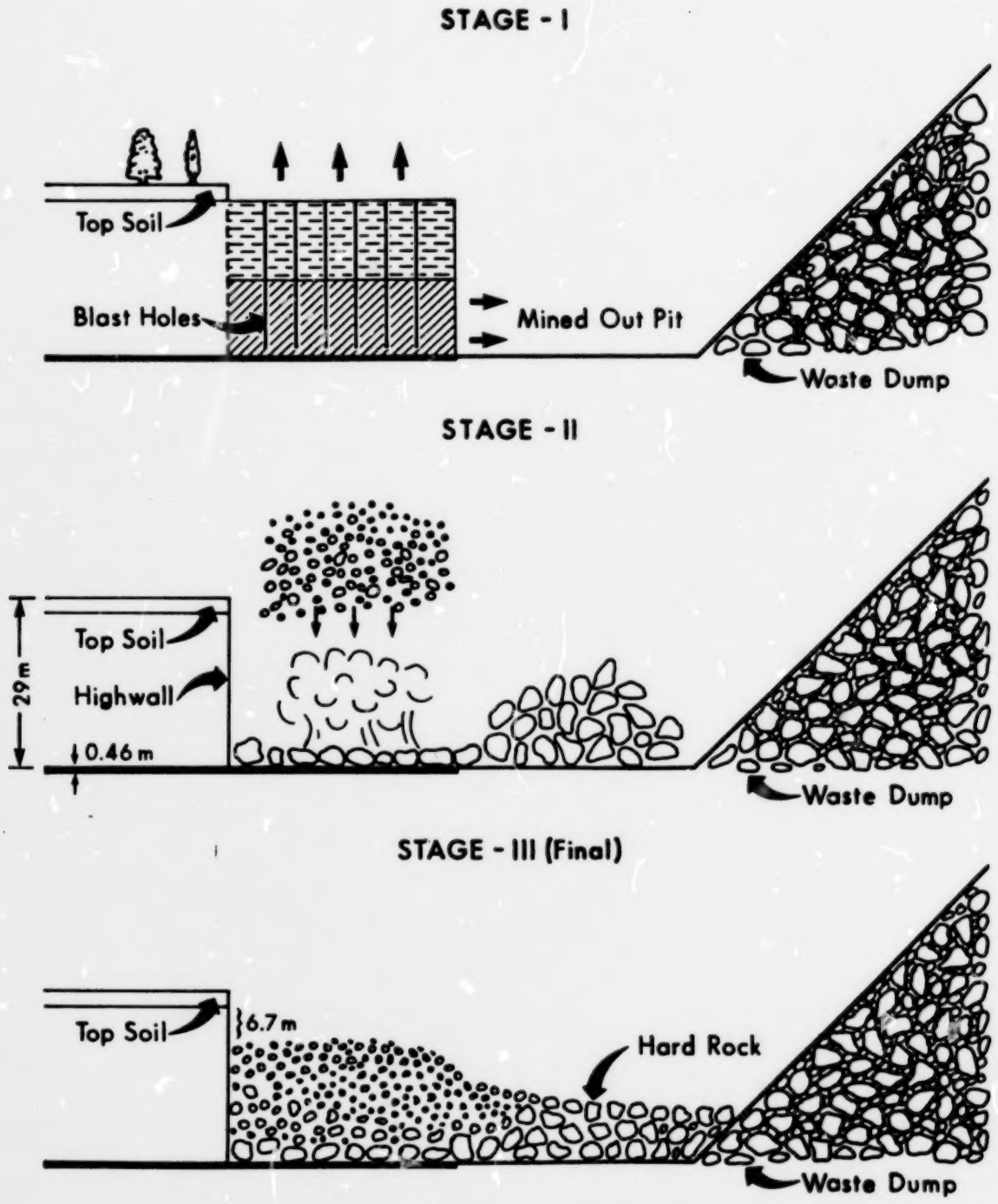


Fig. 7 Movement of Rocks in Blast Casting

Fig. 8 - Muck Profile after Blast Casting, Minto Mine.

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